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Here Comes the Sun

A Guide Book for Massachusetts People
Interested in Learning About Solar Energy

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This booklet was prepared to give you a better understanding of solar energy and how it works. Because many different people are interested in solar energy, and have a variety of needs and questions, we have tried to design a booklet which will be useful to all those people and help answer a wide range of questions.

The first section contains some facts on solar energy, while the second goes into more detail about solar systems, explaining how they work. Commonly asked questions about these systems are answered in the third portion. Finally, the last two sections discuss the economics of solar energy and consumer protection.

Because the field changes constantly as solar energy industries grow and consumers become more interested, we have kept additional information on solar firms, legislation, and background material separate, so that we can update and revise it regularly.

If you are interested in more information on solar energy after reading this booklet, please fill out and return the last page.

Jeffrey Brauer, Pat Moriarty, Henry Shir, Peter Thorne, and Ann Wheeler of the Solar Action Office deserve special recognition for their major contributions toward the preparation of this booklet. In addition, we would like to thank the staff of the Massachusetts Energy Office for their assistance, especially Pat Baker, Russel Ito, Harvey Michaels, Brian Murphy and Brenda Nashawaty.

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I. INTRODUCTION

There is no question that for you, as a Massachusetts homeowner, solar energy is rapidly becoming an attractive alternative to paying ever increasing electricity, gas, and oil bills. Solar energy is simple to use for heat and hot water and has been successfully used for over 20 years in some American homes. Sunlight is plentiful and will not become more expensive or less plentiful in our lifetimes. For many people, solar equipment is a practical and economical energy saving option today, and with rising fuel costs more and more people will be turning to solar energy. This booklet will help you to determine whether solar is right for you.

Some Facts About Fuel in Massachusetts

One point is clear: Massachusetts is vitally dependent upon existing supplies of fossil fuels such as oil and gas. These fuels are destined to only become more expensive.

- Oil is the source of 85% of all the energy used in the Commonwealth.
- 60% of the oil used in the Commonwealth comes from foreign sources.
- Massachusetts residents pay 38% more for energy than the national average.
- This incredible dependence on oil is reflected in the cost of energy we use in our homes. 35% of all the energy consumed in Massachusetts is used for space heating.
- The cost of heating the average Massachusetts home has risen 110% in the last 4 years.

Some Facts About Solar Energy in Massachusetts

Solar energy can provide a way to combat skyrocketing fuel costs. While some solar systems are expensive to buy, they can save you enough money over their lifetimes to more than justify their high initial cost.

- Solar energy systems *do* work in Massachusetts. Most areas of this state get 70% as much sunlight as Florida or southern California.
- With our long winters and high energy costs, New England is an area where using solar energy is more practical and economical.
- The sunlight falling on Boston on one sunny day could heat 25,000 homes for an entire year.
- Solar heating systems create no pollution or waste and have less fire and safety problems than fossil fuel systems.

II. SOLAR SYSTEMS FOR YOUR HOME: HOW THEY WORK

Solar systems can be used in many ways, from helping plants grow to generating electricity and providing hot water and heat for your home. The following are just some of the ways that solar energy can be used.

Passive Solar Systems

Passive solar systems heat buildings without the complicated pumps, plumbing, and machinery associated with other types of solar systems. Passive solar systems are currently the most economical systems to build and use, because they are similar to conventional construction in design and use a minimum of moving parts. The basic principle behind passive solar energy is the "greenhouse effect". Sunlight shines through the south facing windows and is absorbed by the building's interior. The sunlight is then converted into heat energy which is trapped inside the building. Presented below are three ways of using passive solar systems. These are the "direct gain" of sunlight through large, south facing windows; the use of a south facing "thermal storage wall"; and the incorporation of a greenhouse into a building's south facing wall.

Direct Gain

This approach works best when the following conditions are met:

1. The south facing windows have two layers of glass (double glazed).
2. The windows have insulating shutters or curtains to keep the heat collected during the day from being lost at night.
3. The windows are shaded by roof overhangs or eaves to prevent the summer sun from overheating the building.
4. The building is made of materials which can store a great deal of heat (having a high thermal mass), such as concrete floors or masonry walls which are insulated on the outside.

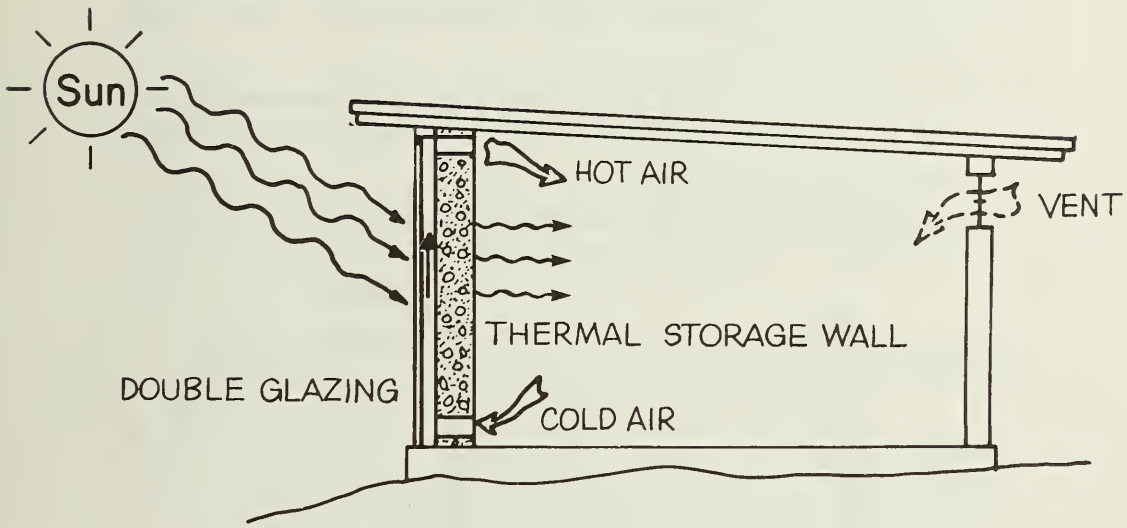
Passive Solar Heating Showing Use of Roof Overhangs

Summer Winter

Thermal Storage Wall

This approach uses a thermal storage wall and works best when the south facing wall is:

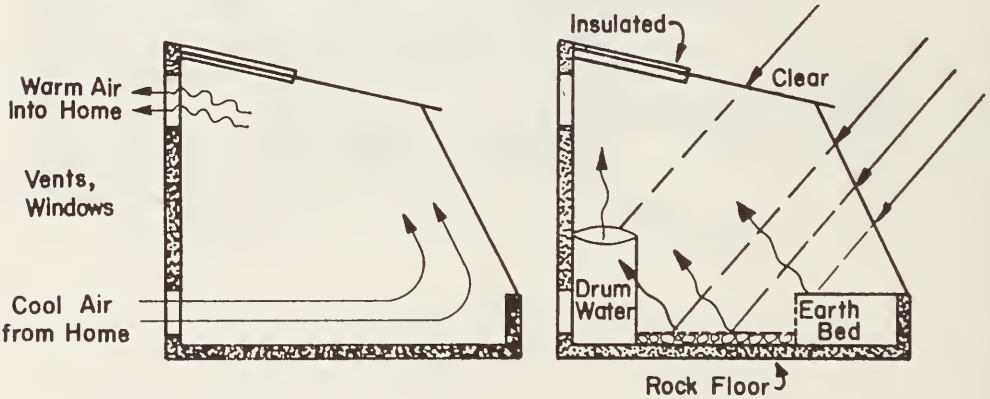
1. Made of a material which can store large amounts of heat such as masonry or containers filled with water.
2. The storage material is painted black or another dark color to absorb the maximum amount of sunlight.
3. One or two layers of glazing are placed a few inches in front of the thermal storage wall to minimize heat losses to the outside.
4. Movable insulation is placed in front of the glazing and storage wall to minimize heat losses at night.



Attached Solar Greenhouses

Solar greenhouses can be attached to the south side of a building to heat the living space and provide a place to grow food year-round.

1. Solar greenhouses can combine the best features of both the "direct gain" and "thermal storage wall" systems. Sunlight which passes through the greenhouse glazing is used by growing plants and is also converted to heat which is absorbed by a storage wall or floor. To increase the storage capacity, water filled drums can be put in the greenhouse (see diagram).
2. The heat storage, warmed up during the day, radiates heat to both the main building and the greenhouse to keep them warm at night.
3. The greenhouse can be built against existing doorways and windows to circulate the warm greenhouse air into the living space (see diagram).
4. An overhang or other device should shade the water filled drums and inside walls to prevent the summer sun from overheating the greenhouse.
5. At night in cold climates, movable insulation should be placed over the glazing to minimize heat losses.



**The drawings were taken from the following reference by permission of the authors: W. F. Yanda and Susan Yanda,* An Attached Solar Greenhouse, *(in English and Spanish). Santa Fe: The Lighting Tree, 1976, pp. 3-4.*

All of the components of a passive solar system must be carefully designed to work together if such a system is to work well and be economical. The design techniques for passive solar systems are well known today, so that, anyone considering building a new home or any type of addition to an existing home should seriously consider a passive solar system. Even for many existing homes, passive solar systems can be effectively used so that they will be the most cost-effective way of using solar energy. Additional information on passive solar designs is available from the Solar Action Office.

Active Flat Plate Collector Systems

Active flat plate solar collector systems are presently the most common type of solar equipment used in homes. Active systems are different from passive systems, because they use electric blowers or pumps to operate. They are much less costly than concentrating or photovoltaic systems and are suitable for domestic hot water and space heating.

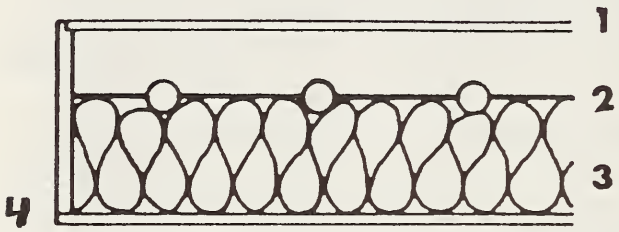
The "greenhouse effect" plays an important role in the operation of flat plate collector systems. The collectors act as a heat "trap". Sunlight passes through the transparent covers of the collector and strikes the absorber plate. The sunlight is converted into heat energy, and the covers trap this heat within the collector space. The heat that builds up within the collectors is carried away to the storage area by a heat transfer fluid which circulates throughout the system. The heat is stored in insulated tanks for later use and distributed to the building as it is needed. The system is described in greater detail below.

In order for active solar systems to perform effectively, it is important that they be installed properly. You will get the maximum energy savings from your solar system provided the following conditions exist:

- The equipment faces within 20° of true south. True south is 15° west of magnetic south. This orientation will maximize direct exposure to the sun throughout the year.
- The system is not oversized or undersized. This is important because trying to provide too little or too much of your hot water or heating needs may mean that your equipment will take a long time to pay for itself.
- The collector is unshaded between 9 AM and 3 PM all year-round. (The sun is at a low point of 28° above the horizon in the winter, and, in the summer, it is at a high point of 72°.)
- The collectors are tilted at the optimum angle roughly equal to the latitude (which for Massachusetts is 42°) for domestic hot water heating and the latitude plus 15° for space heating (57°).

Flat plate collector systems have six major components:

1. the COLLECTORS
2. the HEAT TRANSFER FLUID
3. the PIPES or DUCTS and their INSULATION
4. the STORAGE
5. the BLOWER or the PUMP
6. the CONTROLS



1. **The COLLECTOR** consists of the following components:
   One or more transparent cover plates made of glass or plastic (1);
   An absorber plate, usually made of copper or aluminum but sometimes made of galvanized steel. The absorber plate is painted black or a dark color to absorb the maximum amount of heat (2);
   Insulation, placed behind the absorber plate to keep heat from escaping through the back of the collector (3);
   The above components are then assembled in a collector case. (4)
2. **The HEAT TRANSFER FLUID** of a flat plate collector may be air, water, or water with antifreeze added. The advantages and disadvantages of water and air systems will be discussed below.
3. **The PIPING** in a liquid solar collector is almost always copper, because it has a high resistance to corrosion. If a collector uses air for its heat transfer medium, the **DUCTS** are similar to those found in standard construction. All ducts and piping must be properly **INSULATED.**

4. **The type of STORAGE** a flat plate solar system uses depends upon whether the heat transfer medium is air or liquid. The three basic types of storage are WATER, ROCK, and PHASE CHANGING (EUTECTIC) SALTS.

   WATER STORAGE is used with liquid collectors. At this time, it is the most cost-effective type of storage, because it can store large quantities of heat in a comparatively small volume.

   In a solar domestic hot water system, when a toxic transfer fluid such as ethylene glycol is used, it is necessary to use a double-walled heat exchanger to separate the transfer fluid from the drinking water. A double-walled heat exchanger provides two barriers between the toxic fluid and the drinking water.

   ROCK STORAGE is primarily used with air collectors. One to two inch diameter washed river rock is placed in a bin through which heated air is blown. The rock stores the heat for later use. Rock is not as efficient a heat storage medium as water, and therefore requires a greater storage volume.

   PHASE CHANGING SALTS are being used on an experimental basis with both air and liquid systems. These salts change from a solid to a liquid state when heated to approximately 90°F (32°C). This melting process requires the absorption of a great deal of heat energy which is released when the liquid turns back into a solid. These salts can store seven times as much energy as the same volume of water, so that only one cubic foot of these salts would be required for every 15 square feet of collector. Phase changing salts have not been widely used for solar storage to date because of their high initial cost and the problems associated with their long-term reliability. These problems are now being resolved so that within a few years, they should be an accepted and reliable heat storage medium.

5. **BLOWERS and PUMPS** circulate the liquid or air heat transfer medium throughout the solar system.

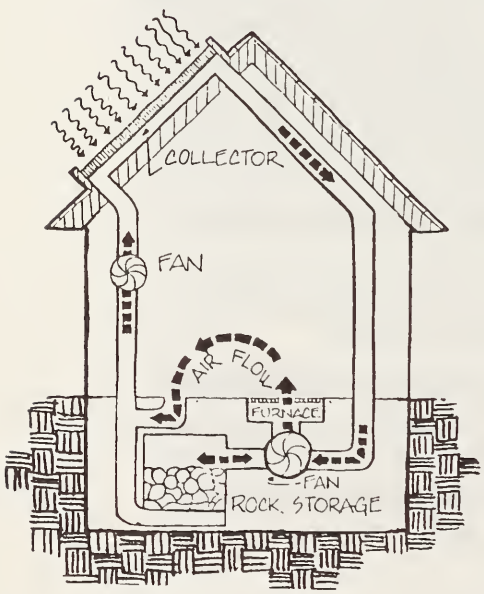
6. **The CONTROLS** of a solar system measure the temperature difference between the collector and the storage medium. When the collector is sufficiently warmer than the storage medium, the controls start the pump or blower which circulates the transfer medium.

COMPARISION BETWEEN AIR AND LIQUID SYSTEMS

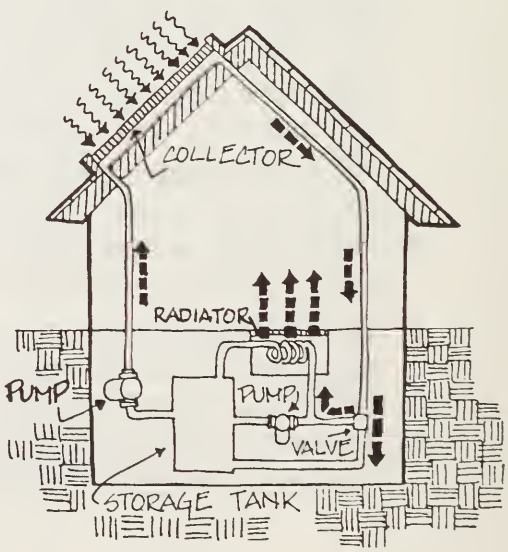
As mentioned before, there are liquid and air active solar systems. In addition, liquid systems are divided into closed loop or open loop systems. In a closed loop system, the collectors and piping are protected from winter freeze damage by using a non-freezing heat transfer fluid which can safely remain in the collectors even during the coldest weather. Open loop systems use a different approach. The collectors and piping are filled with water which will freeze at 32°F (0°C). Therefore, to protect the collectors and piping from freeze damage, the water drains down when the outside temperature approaches freezing.

Below are listed some advantages and disadvantages of the different systems:

AIR SYSTEM



WATER SYSTEM



LIQUID

Advantages:

Liquids hold and transfer heat well. Water is currently the most effective heat transfer and storage medium.

Liquid systems need smaller storage and pipes which will fit where air systems can't.

Liquid systems are best for domestic hot water.

Disadvantages:

The transfer and storage fluids can leak if the system is poorly installed.

The piping and collectors can corrode due to constant exposure to liquids.

Freezing, boiling and excess pressure must be considered.

AIR

Advantages:

No problems with freezing.

Damage from leaks is of little concern.

No boiling or pressure problems.

Since air is used directly to heat the house, there are no efficiency losses due to transferring heat from one liquid to another.

Disadvantages:

The required large volumes of air need oversized ducts (12" diameter) and powerful fans which use considerable energy to move the air.

They are harder to retrofit into existing homes due to space considerations.

Rock storage requires twice the volume of storage as water.

LIQUID CLOSED LOOP

Advantages:

Small circulator pumps are needed which draw very little power.

The collectors and piping can be filled with a corrosion inhibitor which will extend the life of the system.

The freeze protection of antifreeze requires no mechanical system to work.

The most flexible designs and installations are possible with closed loop systems, because they don't depend on gravity to work.

Disadvantages:

The antifreeze must be checked and replaced periodically.

They require more parts and high quality workmanship to work well, and therefore are expensive.

They require either a single or double-walled heat exchanger which is inefficient.

LIQUID OPEN LOOP

Advantages:

They use only water in the collectors and piping, so there is no problem with other chemicals leaking into the water supply.

There are no efficiency losses due to heat exchangers.

Disadvantages:

Correct sloping of the pipes is critical to prevent water from staying in the system and freezing.

They require bigger pumps which are more expensive to run.

The draining mechanism must work perfectly all the time to prevent the system from being damaged in freezing weather.

In addition to the above types of solar systems for home use, there are other types of systems described below which are not yet economical or fully practical for general use, but which show considerable promise for use in the near future.

Concentrating Systems: Concentrating systems reach very high temperatures by focusing sunlight onto a small area from a larger area. They do this using either curved mirrors or Fresnel lenses. Concentrating systems *don't* increase the total amount of solar energy you can collect in a given area as there is only a finite amount of sunlight falling on the collector. These systems are generally more useful for industrial processes, such as driving turbines, than they are for heating homes or domestic hot water. This is because concentrating systems can reach temperatures greater than 300°F (135°C) – far too hot for domestic hot water and quite unnecessary for space heating. Also, concentrators must be rotated to follow the sun and keep its rays in focus. To do this, they need expensive tracking mechanisms.

Solar Powered Cooling Systems: Such systems are not now economical for use in the northeast where the demand for air conditioning is low, and the required high performance equipment is very expensive. Such systems are most appropriate for the south where cooling systems are needed much of the year.

Solar Electric Systems: Solar electric systems use photovoltaic cells to convert sunlight directly into electricity. These cells are generally made of layers of silicon with twin electric conductors which will generate a current when exposed to sunlight. Photovoltaic systems were originally used to power space satellites and are currently being used on an experimental basis in many remote locations where conventional power is too expensive. With the expected advances in production technology, these systems should be available for use in homes in 7-10 years. They are not yet economically feasible for household use in Massachusetts.

III. CONSUMER QUESTIONS

What follows is a review of some of the most commonly asked questions about solar energy. The rest of this booklet will examine in more detail the economics of solar energy systems and how to shop for them intelligently.

Will a solar system make the outside of my house look ugly?

No. Many people find passively solar heated buildings at least as attractive as conventional buildings. In addition, solar collectors look no more obtrusive than skylights if carefully installed on a roof. You can also install solar collectors separately from the house—in the backyard or on the garage.

Won't those pipes run through my rooms and make the inside of my house ugly?

No. Solar piping in your home should be no more conspicuous than regular plumbing. Besides, many passive solar systems don't use any pipes at all.

Will the rooms underneath the solar panels get unbearably hot?

No. Solar panels collect the heat and transfer it to a remote storage area. They don't magnify it or diffuse it into the rooms below.

Won't I have to tear up the roof to put the solar panels on it?

No. The panels can be installed over the shingles.

We get lots of snow here. Won't it cover up the panels and make it impossible to use the solar system?

No. The snow will just slide off the collectors, because they have a smooth glassy cover and are tilted to face the sun.

Don't I need a back-up system?

Yes, you'll need some kind of conventional back-up system to use in a long sunless spell.

Should I buy now, or later, when improvements in solar technology have taken place?

There is no doubt that solar systems will improve with time. However, costs for tomorrow's solar systems may increase, as the cost of their raw materials continues to rise.

IV. ECONOMICS OF SOLAR ENERGY

Solar energy can be a good investment depending on your circumstances. But before deciding to buy solar, you should consider those energy saving investments which are usually more economical than solar, such as insulating and weatherizing your home. If you are considering a solar, total-home heating system, your home must be thoroughly insulated, since it is important to save as much of the energy you collect as possible. This means you should provide the equivalent of R-19 insulation in the roof (6" of fiberglass insulation), R-11 in the walls (3½" of fiberglass insulation), double-glazed windows and weather stripping. If your interest is in a solar domestic hot water system, your water heating bill can also be reduced through insulation. Standard four inch thick fiberglass insulation, wrapped around your hot water tank, can save up to 40% of your water heating bill.

For more detailed information on insulation and weatherization, you can call the Massachusetts Energy Office at (617) 727-4732 or the Toll Free Energy Phone at 1-800-922-8265.

Another factor affecting the economics of solar is whether you intend to install it in a new or existing home. Solar systems are usually cheaper in new construction. For example, many of the passive solar systems discussed earlier in this booklet can easily be incorporated into the design of a new house, saving you money on your heating and air conditioning bills without drastically increasing the costs of construction. In new homes, active solar systems for both space heating and domestic hot water will be *less* expensive than in existing houses, since the collectors can be built into the roof as it is constructed, and the pipes or ducts can be installed as the walls are built.

If you are building a new home, and feel you don't want to install a solar system now but may want to in the future, you should consider orienting the house properly on the site (facing south) and putting in the piping as the house is built. This will cut the installation costs considerably when you add the solar system later.

For an existing home, some passive solar techniques are inexpensive, and if properly used, can save you considerable quantities of energy. For instance, if your home already has large south facing windows, you might consider installing insulated shutters or curtains on the inside to prevent heat loss at night.

The following sections deal with the economics of active solar systems. While passive systems are often more cost-effective, we are not treating them in detail here because of their variety. Write or call the Solar Action Office for more information on passive systems.

How much energy can I get from an active solar system?

The amount of energy you can get from an active solar collector system depends on what you are using it for, the system's efficiency and the quality of the installation. For year-round use, such as heating hot water, it takes about 60 square feet of solar collectors (or three 20 sq. ft. collector panels) to supply one half the hot water needs of a typical family of four in Massachusetts. Such a system will produce yearly the energy equivalent of about 100 gallons of oil, 2,900 kilowatt hours of electricity or 10,200 cubic feet of natural gas. If electricity is used as the back-up in such a system, the solar system will save you about $130 per year at today's prices.

A combination space and hot water heating system will require more collector area. In order to provide 50% or more of the heating needs of the home as well as most of the domestic hot water needs, such a system should contain about 1 square foot of collector for every 2 square feet of floor area. A typical 1200 square foot home with about 600 square feet of collector should annually save you 500-600 gallons of oil, or 12,000-15,000 kilowatt hours of electricity, or 40,000-50,000 cubic feet of natural gas.

How much do active solar systems cost?

A typical *solar water heater* designed to provide 50% of the hot water needs of a family of four costs $1800-$3000 installed. If the solar system is installed on a do-it-yourself basis, you can expect a reduction of about 20-30% from this price. However, you should not install a system yourself unless you have a solid background in construction, plumbing and electrical work. (The Solar Action Office has published Solar Water Heater Installation Guidelines for homeowners and professionals. Write or call for a free copy.)

An active *solar space heating system* designed to provide 50% of the heating needs of a typical 1200 square foot house will cost about $7,000-$13,000. If the system is effective, and if the installation can be done for a reasonable price, then solar energy may well be less expensive than electric heat for your home. Also, as fuel costs increase and as solar systems improve, solar energy may be the least expensive way to heat your house within a few years.

How do I know if an active solar system makes economic sense for me?

The most economical use of solar energy now is in the heating of domestic hot water, especially where electricity is used as the back-up source of energy.

Although a solar water heater costs 4-5 times as much as a conventional water heater, it costs much less to operate because of the fuel it saves. When comparing a solar water heater and an electric water heater, you should look at the "life-cycle" cost of each system. The "life-cycle" cost simply means the total cost to buy and run the system over a period of years. When the life-cycle cost of solar and conventional water heaters are compared, solar looks like a good investment. The following example will help to show this.

EXAMPLE: Mr. E installs an electric hot water heater for $400 for his family of four. Ms. S decides to install a solar hot water heater with electric back-up for $2000 for her family of four. The solar system is designed to provide 50% of her family's hot water needs.

Although the initial cost of Ms. S's solar water heater is high, her fuel costs over the years will only be half those of Mr. E. As electricity prices grow, this cost difference turns out to be important.

Assuming the average cost of electricity is now 4.6¢ per kilowatt hour and grows at the rate of 8% per year, Mr. E will pay about $7400 for electricity over a 15 year period just to heat his hot water. Ms. S will pay half that amount. Furthermore, Ms. S's system will have paid for itself in 9 years; that is, in the ninth year, her total electricity savings will exceed $1600, or the difference between her system and the conventional heater of Mr. E. From then on, except for minimal maintenance costs, Ms. S's solar system provides her with essentially free energy for one half of her hot water needs.

Another way of looking at the economics of Ms. S's solar system is to compare the two systems from a savings point of view. Suppose that Mr. E takes the $1600 he saves by not purchasing a solar system and puts it in a savings bank at 6% interest for 15 years. Suppose also that Ms. S takes the money she saves in fuel bills from her solar system every year and puts it in the bank at 6%. If you compare the two investments after a 15 year period, it turns out that Ms. S has over 20% *more money in the bank* than Mr. E ($1600 at 6% compounded for 15 years is $3834; the value of the solar savings at 6% for the same period is $4605). In fact, by investing in solar over this period, Ms. S has earned 7.3% on her money—clearly not a bad investment at all! The solar system begins to look even better when you consider that it should also increase the value of Ms. S's home.

When compared with the costs of fuels such as gas or oil, solar water heaters are not as attractive a long term investment. And, as said before, active solar space heating systems are, at this time, even less clearly a good long-term investment. The picture will change dramatically, though, if fuel prices rise even more rapidly than 8% per year, or if federal tax credits or low interest loans are passed which would bring down the initial cost of the systems.

If you would like to find out whether solar makes economic sense in your particular circumstances, you can write to the Solar Action Office and ask for a solar economic worksheet which we have prepared. The worksheet will guide you through calculations similar to those used in the example above so that you can determine what your savings might be using a solar water heater.

If I decide to buy a solar system, isn't it true that banks will never give me a loan because solar is still a big risk?

No. Most banks in Massachusetts are willing to give loans for solar energy systems right now. Ask them for a home improvement loan. Over 125 banks in Massachusetts are participating in the nation's first statewide program of reduced interest home improvement loans for solar systems and energy conservation measures. They will write loans for solar systems at less than their market rates for regular home improvement loans. For the most up-to-date information concerning participating banks, call the State Energy Phone, toll free, at 1-800-922-8265.

What about my property taxes? Will my home's valuation increase if I add a solar unit? Are there other tax breaks I can take advantage of if I install a solar energy system?

Massachusetts has passed a law protecting homeowners and businessmen from having their property valuation increased as a result of investing in a solar or wind powered system. As the law now stands, you will not have to pay taxes for a period of 10 years on the value that is added to your property as a result of the solar or wind powered system.

Also, there is a new law, passed in early 1978, which provides for an exemption from the state sales tax for sales of equipment directly relating to any solar, wind powered or heat pump system. In order for you to qualify for this tax break, the solar or wind powered system must be installed in your principal residence.

Finally, small businesses and corporations will now find it easier to switch to solar energy, because they can deduct the money they spend on the solar or wind powered system on their state income tax return, provided certain conditions are met.

For more details concerning these laws and other solar legislation, clip out and return the sheet at the end of this booklet.

V. PROTECTING YOUR INVESTMENT

Here are a few tips for potential buyers of solar energy systems. This is not intended to be an all-purpose buyer's guide. Rather, it points out some consumer dangers to avoid and some guidelines to follow to insure that you get the most value for your solar dollar.

How do I find out who sells solar systems?

The Solar Action Office has prepared a list of solar manufacturers, installers, dealers, distributors, and builders that do business in Massachusetts. Clip out and return the back page of this booklet for a copy of the list. (This list does not imply an endorsement of the solar products sold.)

Before you buy, ask for proof that the product will perform as stated.

The proof should come from an independent laboratory or university. Ask for a copy of the report itself, not of what the manufacturer claims the report said. An increasing amount of solar equipment is being tested to meet the U.S. Department of Housing and Urban Development (HUD) Intermediate Minimum Property Standards for solar equipment. Reputable manufacturers should be willing to supply these test results. Also, the Solar Action Office has compiled a list of solar domestic hot water systems which have been approved for use in Massachusetts under the HUD Hot Water Initiative Grant Program. This approval is limited to the HUD program only and does not suggest approval or endorsement for any other purpose. However, if you are considering the purchase of a solar domestic water heater, you might find this list valuable in comparing systems. For a copy of this list, write the Solar Action Office. Finally, ask for the names of other people who have purchased solar systems from the manufacturer and check personally with them. Don't forget to check with the Consumer Affairs Office and the Better Business Bureau, as well as local solar energy organizations.

Be careful of sellers who use Post Office box numbers.

Although many legitimate businesses use these as a convenient way to receive bills and orders, it is also a common tactic of the fly-by-night operator to use a Post Office box number, operate a territory until the law starts closing in, and then move and take a new name and territory. Find out from the seller where his place of business is and how long he has been there and ask for his financial references.

Solar components are like stereo components—some work well together, some don't.

If the system you are considering is not sold as a single package by one manufacturer, you should be sure that your installer knows how to assemble a good solar system.

Be sure you know specifically who will service the solar system if something goes wrong.

Don't settle for a response that any plumber or handyman will do. Obtain written assurances that specify who will service the system if it fails.

Remember to get a binding written estimate of the installed cost of the solar unit. The installer, not the consumer, should bear the risk of inaccurate estimates of installation costs.

Don't buy solar equipment without getting installation costs included in the contract, unless you plan to install the system yourself. You should only consider installing the system yourself if you have a solid background in construction, plumbing and electrical work.

Before you buy, be sure your solar system is adequately protected by warranty.

A strong warranty is an effective way to protect yourself from being ripped-off. Require a written warranty from the manufacturer. Make sure you understand the provisions of the warranty. Federal law requires that all the conditions of the warranty be stated clearly. Is it full or limited? Which parts of the system are covered and for how long? There should be a five year manufacturer's warranty on the major components of the system, including collectors, heat exchanger and tank. If a professional installer puts in your system, you should also obtain a written

warranty from the installer protecting you against failure of the system or any of its components for at least one year. It is important to determine the obligations of the manufacturer and contractor. The manufacturer will normally not provide a warranty against system failure which is caused be defective or faulty installation. To obtain a copy of the Solar Consumer Protection Pamphlet which discusses warranties, clip out and return the sheet at the end of this booklet.

Once you get a solar system, don't change your energy use patterns just because you think you have lots of free energy.

Conservation of energy and effective insulation still count if you want to reduce your monthly bills. Don't blame the seller of the solar system if you keep your doors open during the middle of the winter.

If you have any other questions, or problems with your solar purchase decisions, call the Solar Action Office.

As interest in solar systems grows, the state should be getting more money for consumer protection programs. Meanwhile, we are more than willing to help. If you have any questions, call or write:

Massachusetts Solar Action Office
Room 1413
One Ashburton Place
Boston, Massachusetts 02108
(617) 727-7297

VI. SUN LANGUAGE
A Solar Vocabulary List

Absorber, or Absorber Plate: A surface, usually blackened metal in a solar collector, which absorbs solar radiation and becomes hot.

Absorptance: The ratio of energy absorbed by a surface to the energy striking it. Black matte surfaces have high absorptances, while white or shiny metal surfaces have low absorptances.

Active System: A solar heating or cooling system that requires the external mechanical power of fans or pumps to move the heat collected by the system.

Ambient Temperature: The outdoor air temperature.

Bioconversion: Use of agricultural or municipal wastes to provide fuel.

British Thermal Unit: (Btu) A unit of energy defined as the amount of energy required to heat one pound of water one degree Fahrenheit. A gallon of fuel oil, when burned in an oil burner, will produce about 100,000 Btu's. A cubic foot of natural gas contains 1,000 Btu's. A kilowatt hour of electricity contains 3,413 Btu's.

Collector Efficiency: The ratio of usable heat energy extracted from a solar collector to the solar energy striking the collector.

Collector or Solar Collector: A device which converts sunlight into heat energy. It is made of a number of parts including a cover plate, an absorber plate, back insulation, and an enclosure.

Collector Tilt: The angle measured from the horizontal at which a solar collector is tilted to face the sun.

Concentrator: Reflector or lens designed to focus a large amount of sunshine into a small area in order to increase the temperature in that small area.

Conductivity: The ease with which heat will flow through a material which is determined by the material's physical characteristics. Copper is an excellent conductor of heat; insulating materials are poor conductors.

Convection: When two surfaces, one hot and the other cold, are separated by a thin layer of air, moving air currents (called convection currents) are created which carry heat from the hot surface to the cold.

Emittance: This is the measure of the heat re-radiated from the solar collector's absorber plate.

Galvanic Corrosion: This can result when the heat transfer fluid makes contact with two different metals which are not physically or electrically isolated.

Heat Transfer Fluid: Any substance such as air, water, or anti-freeze, used to carry away the heat collected by the absorber plate.

Hybrid Solar System: A system that uses both active and passive methods to operate.

Insolation: The amount of solar radiation striking an exposed surface, often expressed in terms of Btu's per square foot on a horizontal surface. In Boston, the average insolation is 1,110 Btu's per square foot per day.

Kilowatt: (Kw) One thousand watts of power, equal to 1⅓ horsepower.

Kilowatt-Hour: (Kwh) The amount of energy equivalent to 1 kilowatt of power being used for one hour (or 3,413 Btu's).

Passive Solar System: A solar system which uses little or no mechanical energy to operate. (see detailed description in text)

Photovoltaic: This refers to the direct conversion of the sun's energy into electricity, usually by means of a device called a photovoltaic or solar cell, often made of silicon.

Pyranometer: An instrument for measuring solar radiation.

Radiation: Any object that is warmer than its surroundings radiates heat waves (similar to light waves but invisible) and thus emits heat energy called radiation.

Re-radiation: The heat emitted by a warm collector plate to its cooler surroundings.

Selective Surface: A special coating sometimes applied to the absorber plate in a solar collector. The selective surface absorbs most of the incoming solar energy and re-radiates very little of it.

Solar Tracking: Adjusting a solar collector so that it always faces the sun squarely.

Sun Rights: (or solar access) A legal issue concerning the right of access to sunlight.

Therm: A measure of energy equal to 100,000 Btu's.

VII. INFORMATION REQUEST SHEET

I'm interested in further information on solar. Please send me the following:

- ☐ The Solar Energy Economic worksheet to help me figure out the costs and benefits of solar energy for my home.
- ☐ A list of solar legislation in the state.
- ☐ A solar energy bibliography.
- ☐ A list of solar energy firms including: 1) manufacturers, 2) dealers, distributors, and manufacturer's representatives, 3) architects and engineers, 4) builders, 5) installers, and 6) researchers. (Circle the lists that you want.)
- ☐ A list of solar hot water systems approved for use in the HUD Grant Program.
- ☐ Solar Water Heater Installation Guidelines, to help me install a solar water heater system and avoid the common installation errors.
- ☐ A Passive Solar Energy Booklet, to give me passive energy ideas and information about the economic benefits for 1) consumers, 2) builders, and 3) architects. (Circle the booklet you want.)
- ☐ A Monitoring Booklet, to show me how to monitor my own solar system.
- ☐ A Solar Consumer Protection Pamphlet, to show me how to shop for solar and avoid consumer mistakes.
- ☐ A Solar Energy Grant Guide, to show me where and how to apply for solar grants.
- ☐ Please keep my name and address on the solar mailing list, so I can be informed of new developments in the field.

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Name

_____

Address

_____

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Phone

Mail this page to: Massachusetts Solar Action Office
Room 1413
One Ashburton Place
Boston, MA 02108

For further information or questions on solar, call: (617) 727-7297

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